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INQUILINES IN EGG NESTS OF PERIODICAL CICADAS (HOMOPTERA: CICADIDAE)

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Abstract.—Egg nests of brood X of 17-year periodical cicadas (*Magicicada* spp.) of 1987 were occupied by four orders of Insecta. Species of Pseudococcidae and Eriococcidae (Homoptera) developed from eggs to adults, larvae of two species of Cleridae and one species of Coccinellidae (Coleoptera) were found, larvae of Torymidae and immature and adult Scelionidae (Hymenoptera) were present, and two species of Gryllidae (Orthoptera) deposited eggs in the cicada egg nests. Specimens were identified to family, genus or species. Mealybugs entered nests where unhatched cicada eggs and dead cicada nymphs were present; all other species occupied nests containing only cicada egg shells. Previously none of these insects were known to deposit eggs or to molt in periodical cicada egg nests.

Key Words: Cicada egg nests, coccoids, beetles, wasps, crickets

This article records the insects and eggs, other than cicadas themselves and their eggs, that we found in egg nests of brood X of 17-year periodical cicadas (*Magicicada septendecim* (L.), *M. cassinii* (Fisher), and *M. septendecula* Alexander and Moore) of 1987. These observations complete the study of brood X made by Stoetzel and Russell (1991).

Materials and Methods

We examined over 3500 egg nests, a term used by Marlatt (1907), Snodgrass (1921) and Lloyd and White (1976), for pockets of eggs in the bottom of punctures or slits made by female periodical cicadas in twigs. The egg nests, with one exception, were from trees and shrubs in a wooded suburban area of 0.25 ha in Silver Spring, Montgomery County, Maryland; some nests were in twigs pruned from shrubs less than 5 m high, while others were in twigs that dropped from beech and oak trees ascending 22–28 m.

Our examination of egg nests began in mid-May 1987 and continued through October 1990, except for December to March of each year. Inquilines in cicada nests were first found in mid-June 1987 and additional species were observed in 1988–1989; living examples of only *Planococcus japonicus* Cox were found in 1990. New information was obtained on the diversity of the inhabitants of cicada egg nests and on the biology and habits of some of them.

Non-cicadan insects in cicada egg nests were recorded by Andrews (1937) who mentioned beetles and aphids; by Hopkins (1900) who reported woolly aphids and who was cited by Smith and Linderman (1974); and by Simon (1988) who listed scale insects, woolly aphids and unspecified pests. In our study we identified to family, genus or species specimens of the Homoptera, Coleoptera, Hymenoptera and Orthoptera.

Fig. 1. Filamentous covering of *Planococcus japonicus* on an azalea leaf.
Fig. 2. *Planococcus japonicus* in egg nest of periodical cicada.

The accessibility of cicada egg nests to other insects changed considerably during 42 months. In the spring and early summer of 1987, many egg nests were sufficiently open to permit entrance by small insects; thereafter, access depended on the extent and nature of plant growth around nests. Some punctures became wider, and nests remained exposed while others varied in size and shape, and some were completely closed, with or without a brush of wood fibers remaining in the center of the wound. The healing of periodical cicada punctures was discussed by Lloyd and White (1976), White and Lloyd (1979), and Stoetzel and Russell (1991).

Results and Discussion

Homoptera.—Homoptera were the most numerous inquilines that we found in cicada egg nests. Coccoidea (scale insects) belonging to the Pseudococcidae (mealybugs) and Eriococcidae (eriococcids) were present on Ericaceae and Fagaceae, and one eriococcid was abundant on Ulmaceae.

Planococcus japonicus Cox (1989), a species misidentified by Ezzat and McConnell (1956) as *Planococcus azaleae* (Tinsley) and easily confused with *Crisicoccus azaleae* (Tinsley) of Ferris (1953) and McKenzie (1967), was abundant in twig crotches and on the underside of leaves of azalea (= *Rhododendron* sp.) in the spring of 1987. Mealybugs moved from these locations into cicada egg nests in mid-June and settled among the cicada eggs and egg shells. Adult males and females developed by mid-July when the females produced a quantity of loose, white filaments and deposited eggs. Mealybugs remained in cicada egg nests during the summer and some moved away as the punctures closed. The insects and their white, filamentous coverings (Fig. 1)

Fig. 3. *Eriococcus* sp. in egg nest of periodical cicada.
Fig. 4. Ovisac of *Eriococcus* sp. in egg nest of periodical cicada.
Fig. 5. Cocoons of *Eriococcus* sp. in egg nest of periodical cicada.

were present on leaves and twigs of azalea through October 1990.

Planococcus japonicus was not found on other azaleas growing near the infested plant. On 5 June 1989, however, we detected *P. japonicus* (Fig. 2) in cicada egg nests in fallen twigs of beech (*Fagus grandifolia* J. F. Ehrh.) and white and pin oaks

Fig. 6. *Gossyparia spuria* in egg puncture of periodical cicada.

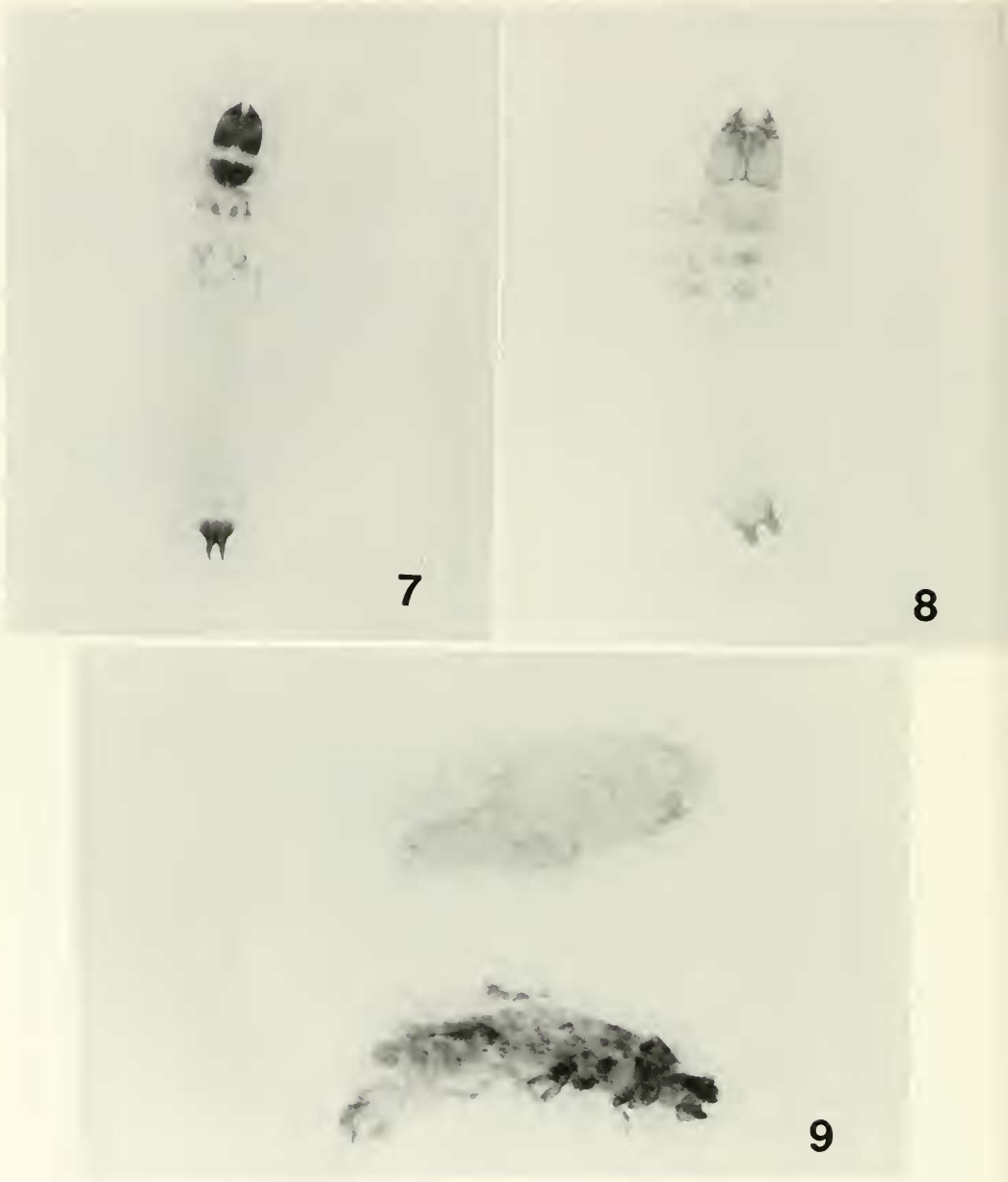
(*Quercus alba* L. and *Q. palustris* Muenchh.) that were 10–20 m from the infested azalea. By 15 June 1989 and into early July, females had produced a thin covering of white filaments in which they deposited eggs. On beech, living adults were not observed after 8 August 1989, but dead ones were found in the fall of 1990 in cicada punctures that were not well healed. In November 1989, dead mealybugs with white filaments and eggs were present on oaks in egg nests, shallow punctures or rarely in the brush of wood fibers. Mealybugs were scarce on dropped twigs of beech and oaks.

An *Eriococcus* was observed in cicada egg nests in beech 19 July 1988, 15 July 1989 and in nests in white and pin oaks 30 June 1989. Adult females, immatures, hatched and unhatched eggs were present through August of each year.

Newly-molted adult females were pale cream colored; young adults were pale yellow, becoming brownish as they aged. One to three females (Fig. 3) occupied a nest in 1988, usually at the bottom beneath cicada egg shells or in deep punctures. In 1989, after greater plant growth had occurred, they were in deep or shallow punctures above egg nests and were found most often in oaks.

In June and July, specimens had scant, white, silklike filaments over them and a little white powdery wax beneath them, materials that increased and eventually became female ovisacs and male cocoons. Ovisacs and cocoons were formed 23–30 September 1988 in the laboratory in egg nests that were collected in August; none were found out-of-doors at that time, but both were discovered out-of-doors on 31 June and in October and November 1989. A few ovisacs found in 1989 doubtless were formed in a previous year; some were torn, crushed, or holey and others contained partially destroyed adult females, a few eggs and egg shells. Some cocoons were crushed but none had holes that might have been made by predators or parasitoids. Some ovisacs and cocoons had an opening at one end that suggested an exit for the insect. Judging by the gradual accumulation of filaments by adult females, it appeared that they produced the ovisacs, while cocoons of the males were made by an immature stage.

Ovisacs (Fig. 4) were white, oval, 2.50–



Figs. 7, 8. Larvae of two species of Cleridae from egg nests of periodical cicadas.
Fig. 9. Larva of Coccinellidae and egg from which it was removed, from egg nest of periodical cicada.

4 mm long and 1.25–2 mm wide. The outside was composed of silklike filaments, with a little white, fluffy material beneath the filaments and powdery wax at the bottom. Old ovisacs were harder and smoother than newly formed ones. Cocoons (Fig. 5) were white, oval, 1.25–1.50 mm long and 0.50–0.75 mm wide, and were similar in structure to ovisacs except that there was no fluffy material under the outside fila-

Fig. 10. Adult of *Probaryconus heidemanni* from egg nest of periodical cicada.

ments and old ones did not differ from newly-formed ones.

Most ovisacs and cocoons were inconspicuous; in 1988 they were found among cicada egg shells; but later they were in, or along, the edge of punctures, in the brush of wood fibers or beneath pieces of bark. The only plainly visible ovisac was in a node in oak. Eriococcids were scarce on dropped twigs of oak and very scarce on beech.

Another eriococcid, *Gossyparia spuria* (Modeer), the European elm scale (Fig. 6), was abundant along margins of healed punctures, clustered in crevices between the bark and scar tissue; and a few were under the brush of wood fibers. The species was collected from *Ulmus* sp., Bethesda, Montgomery County, Maryland, August 1988, by T. J. Spilman.

Coleoptera.—Beetles were the least numerous of the secondary occupants of periodical cicada egg nests. Two larvae (Figs. 7, 8), representing two species of Cleridae, were collected in June 1988; and a larva (Fig. 9), collected in July 1988 and probably belonging to the Coccinellidae, was removed from an elongate, smooth egg. The larvae were not feeding on eggs or insects when discovered.

Hymenoptera.—Inquilines found in egg nests of periodical cicadas in beech belonged to two groups. Two larvae of a *Torymus* (Torymidae, Chalcidoidea) were collected in September 1988 and 23 May 1989. Adults of *Probaryconus heidemanni* (Ashmead) (Scelionidae, Proctotrupoidea) (Fig. 10) emerged from elongate eggs 31 July 1989. Larvae or pupae were in the eggs which resembled, and may have been, cricket eggs.

Orthoptera.—Two species of crickets (Gryllidae) used egg nests of periodical cicadas as egg hatcheries. Hatched eggs, unrecognized at the time, were first discovered 14 September 1987; similar eggs proved to be those of crickets when juveniles emerged in 1988.

One cricket egg (Fig. 11) virtually filled a cicada egg nest but occasionally two were present with one on top of the other; single eggs usually were enveloped in cicada egg shells which sloughed off if disturbed. After new growth developed around nests, cricket eggs were partially incased in wood; it is difficult to understand how juveniles could

Fig. 11. Cricket egg in egg nest of periodical cicada.
Figs. 12, 13. Immature crickets from egg nests of periodical cicada.

escape under these conditions. Cricket eggs were most numerous in fallen twigs of beech and white and pin oak, but some were in pruned twigs of dogwood (*Cornus florida* L.) and *Rhododendron* sp.

The eggs of both cricket species were cloudy white and very fragile. The eggs of one species were 4–4.5 mm long and 2 mm in diameter; when mounted on a glass slide and examined under a compound micro-

scope, the head end appeared honeycombed and the remainder minutely striated. The smaller cricket eggs were 4–4.5 mm long and 1–1.5 mm in diameter; the head end also was honey-combed but the remainder was smooth. Eggs of both types, some with red eye spots and embryos, were present 1 May to 21 June 1988 and in March 1989. Eggs hatched 6–20 June 1988 but no juveniles emerged completely in the laboratory in 1989. In both years some eggs appeared to be sterile and some collapsed. When juveniles left the eggs, the head end of the shells was deflected but remained partially attached. Numerous cricket egg shells were found in egg nests through November 1989 and several were present through October 1990.

Upon hatching, the juveniles (Figs. 12, 13) were soft bodied and easily injured. They were active immediately and jumped about vigorously.

Unidentified eggs.—Several unidentified eggs were present in periodical cicada egg nests. Some resembled cricket eggs and the coccinellid egg in shape, while others were more slender and still others were perceptibly shorter. Many appeared to be viable and exuded fluid when punctured but red eye spots and embryos did not develop. They were observed in egg nests in various trees and shrubs from May to August 1988 and from April through October 1989 and 1990. Eggs found in the fall of 1990 were embedded in wood. Larvae hatching from the eggs apparently would have to be chewers in order to survive and eventually escape from the wood.

Conclusion

The presence of extraneous insects in egg nests of periodical cicadas demonstrated the usefulness of cicada egg nests for purposes other than the original one. Because some egg nests, or punctures, remain partially open for three or more years, it is possible that they will provide convenient shelters for insects indefinitely.

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Literature Cited

Andrews, E. A. 1937. The seventeen-year cicada, alias locust. Quarterly Review Biology 12: 271–293.

Cox, J. M. 1989. The mealybug genus *Planococcus* (Homoptera: Pseudococcidae). Bulletin British Museum (Natural History) (Entomology) 58: 1–78.

Ezzat, Y. M. and H. S. McConnell. 1956. A classification of the mealybug tribe Planococcini (Pseudococcidae, Homoptera). University of Maryland Agricultural Experiment Station Bulletin A-84: 1–108.

Ferris, G. E. 1953. Atlas of the scale insects of North America. VI: i–vii, 279–506. Stanford University Press, Palo Alto, California.

Hopkins, A. D. 1990. The periodical cicada or seventeen-year locust in West Virginia. West Virginia Agricultural Experiment Station Bulletin 68: [255]–327.

Lloyd, M. and J. White. 1976. Sympatry of periodical cicada broods and the hypothetical four-year acceleration. Evolution 30: 786–801.

Marlatt, C. L. 1907. The periodical cicada. U.S. Department Agriculture Bureau Entomology, Bulletin 71: 1–181.

McKenzie, H. L. 1967. Mealybugs of California. University California Press, Berkeley and Los Angeles. 526 pp.

Simon, C. 1988. Evolution of 13- and 17-year periodical cicadas (Homoptera: Cicadidae: *Magicicada*). Bulletin Entomological Society America 34: 163–176.

Smith, F. F. and R. C. Linderman. 1974. Damage to ornamental trees and shrubs resulting from oviposition by periodical cicada. Environmental Entomology 3: 725–732.

Snodgrass, R. E. 1921. The seventeen-year locust. Smithsonian Report 1919, Publication 2607: 381–409.

Stoetzel, M. B. and L. M. Russell. 1991. Observations on Brood X of periodical cicadas: 1987–1990 (Homoptera: Cicadidae). Proceedings Entomological Society Washington 93: 470–478.

White, J. and M. Lloyd. 1979. 17-year cicadas emerging after 18 years: A new brood? Evolution 33: 1193–1199.